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Paper 3

Preliminary Evaluation of Streamflow Gauging Stations in the Venison Creek Basin

INTERNATIONAL HYDROLOGICAL DECADE · DECENNIE HYDROLOGIQUE INTERNATIONALE

WATER RESOURCES
PAPER 3

PRELIMINARY EVALUATION OF STREAMFLOW GAUGING STATIONS IN THE VENISON CREEK BASIN

By

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ONTARIO WATER RESOURCES COMMISSION

Division of Water Resources

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PREFACE

As part of the Ontario Water Resources Commission's contribution to the International Hydrological Decade, the River Basin Research Branch is carrying out studies of water resources and physical conditions in five basins in Southern Ontario. The basins were selected as being representative of common type areas in the province and the hydrologic studies being undertaken are designed to provide a better understanding of most aspects of the water balance in these areas.

This paper describes the streamflow gauging stations operational in the Venison Creek basin and outlines the problems associated with the collection of reliable hydrologic data from them. It is anticipated that the approach used in this paper will be helpful for the education and training of technicians and technologists who may be responsible for the installation and operation of hydrometric stations and the collection and assimilation of reliable data from them.

K. Symons.

K. E. Symons, Director,
Division of Water Resources.

Toronto, April 1, 1971.

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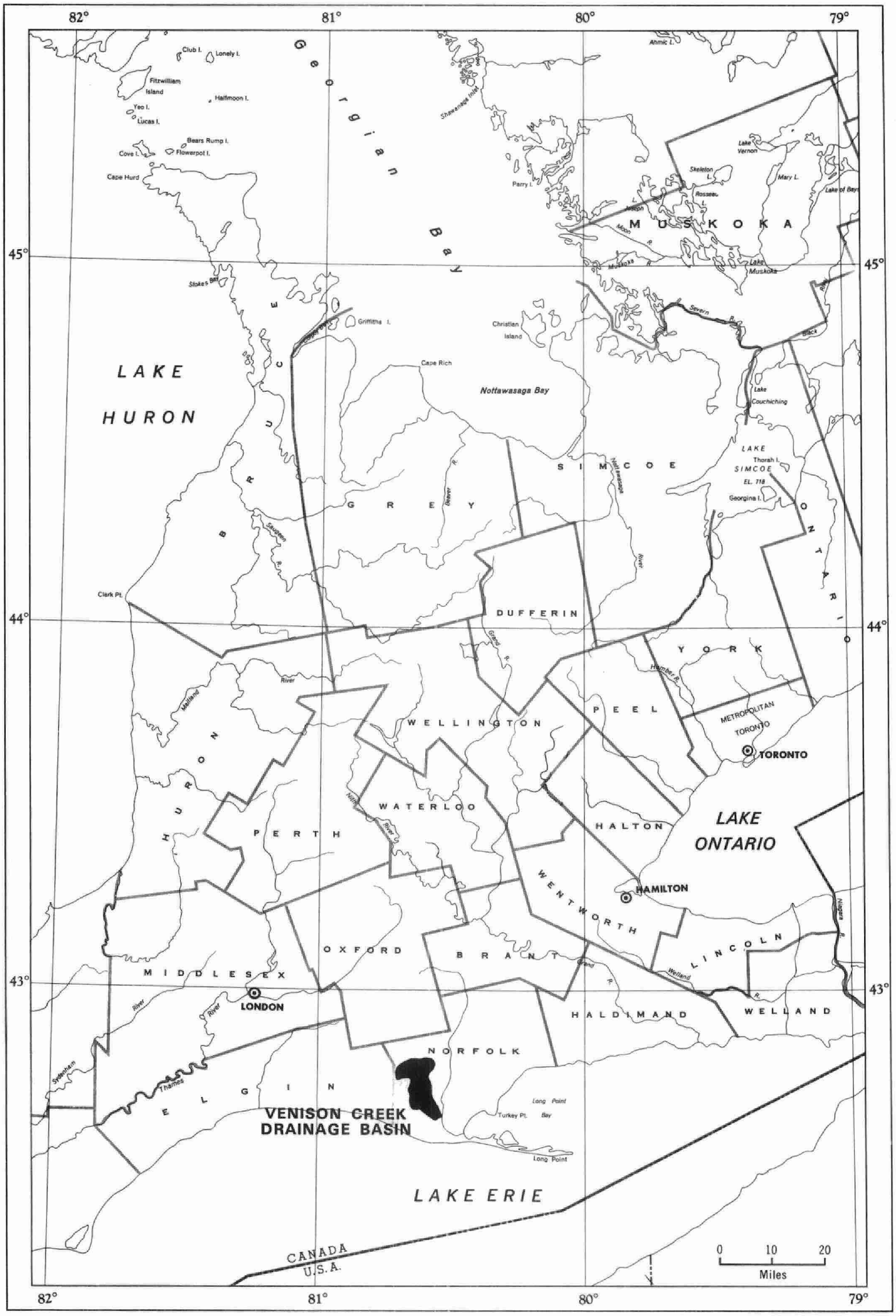

Figure 1a. Location of the Venison Creek drainage basin in Southern Ontario.

PRELIMINARY EVALUATION OF STREAMFLOW GAUGING STATIONS

IN THE VENISON CREEK BASIN

INTRODUCTION

Venison Creek was chosen as a study basin under the International Hydrological Decade program to represent those physiographic areas in southern Ontario composed primarily of sand plains.

The River Basin Research Branch of the Division of Water Resources presently operates three streamflow gauging stations in the Venison Creek basin. In addition to the OWRC stations, the federal Department of Energy, Mines and Resources operates and maintains one additional automatic streamflow gauging station above the junction of Venison Creek with Big Creek. For each station, the report describes in detail the history, available data, data interpretation and station behaviour. Figure 1b shows the locations of the stations in the basin.

STATION 2 GC-9 (original federal station - now abandoned)

Location:
- lot 8, concession V, Township of South Walsingham.
- formerly downstream station for basin.

History:
- 1956 - manual gauge installed, W.S.C.*
- January, 1956 - March, 1961 - miscellaneous measurements (22), W.S.C.
- October, 1963 - recorder installed by W.S.C.

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* Water Survey of Canada, Inland Waters Branch, federal Department of Energy, Mines and Resources, formerly Department of Northern Affairs and Natural Resources.

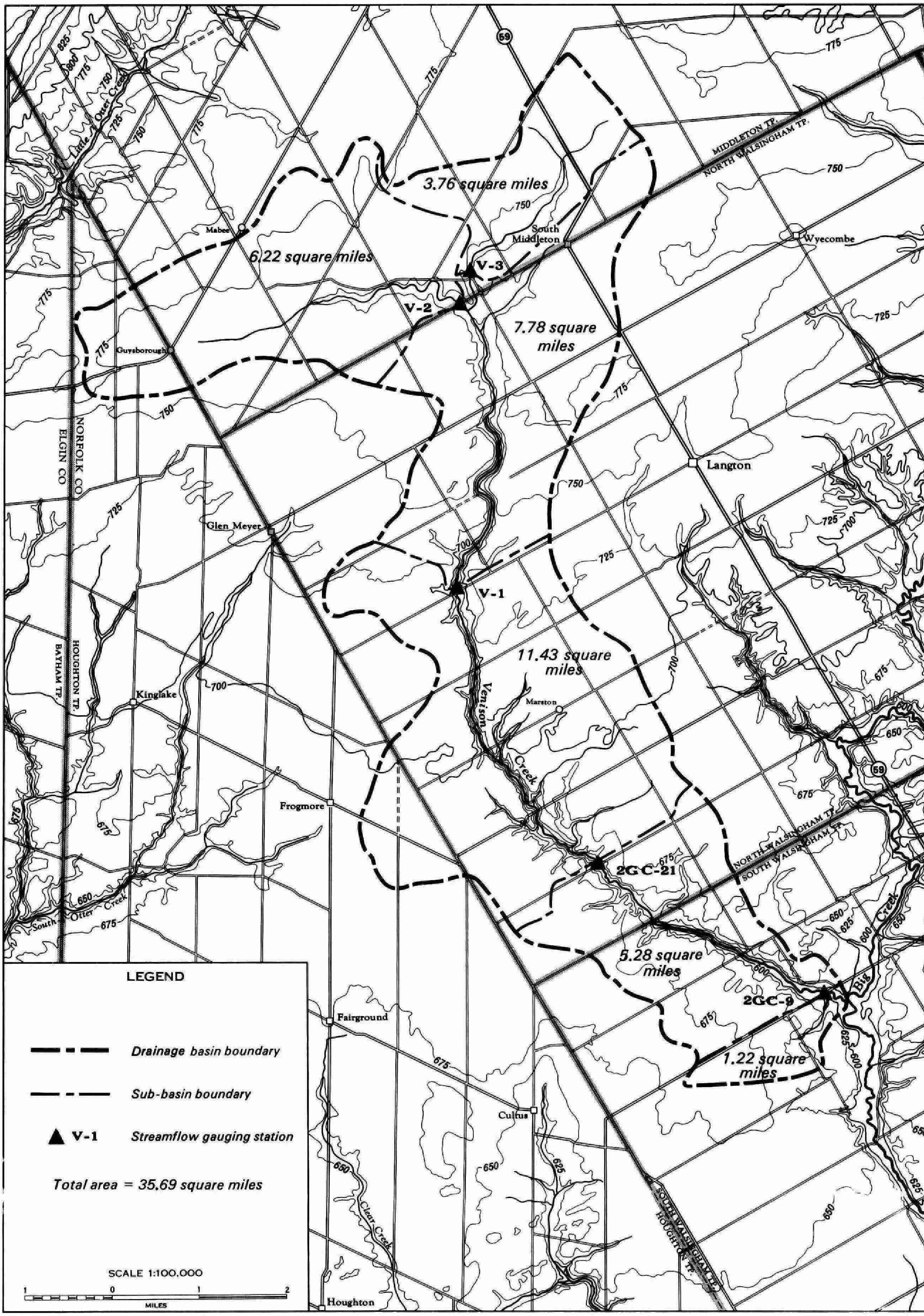


Figure 1b. Location of the streamflow gauging stations, Venison Creek drainage basin.

- October, 1963 - September, 1966 - continuous records, W.S.C., data rating: fair. High flows affected by backwater from Big Creek.
- June, 1965 to date - miscellaneous measurements (5), OWRC, River Basin Research Branch.
- October, 1966 - station taken over by OWRC, Hydrologic Data Branch.
- March, 1969 - abandoned.

Copies of all data can be found in the files of the River Basin Research Branch.

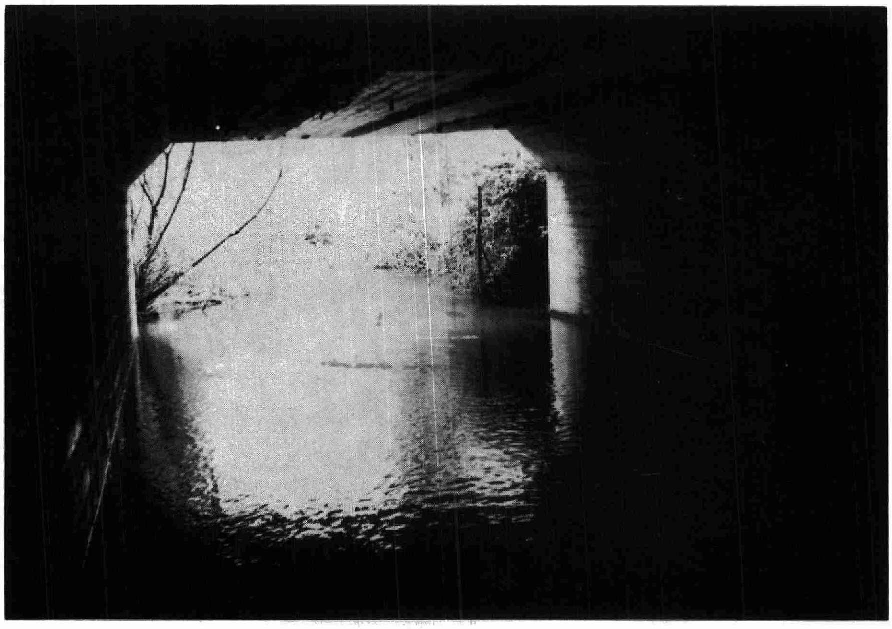
Using the annual reports of daily discharges from October, 1963, to September, 1966, as published by the Water Survey of Canada, and applying the appropriate rating curves to the water-level data collected subsequently by the Hydrologic Data Branch, six annual discharge hydrographs were plotted on graphs i-vi.

For the period January 1, 1965, to April 30, 1965, except for three days, the records were estimated as considerable backwater effect from Big Creek was evident. To avoid the influence of backwater, another station, 2 GC-21, was installed further upstream in 1966, and station 2 GC-9 was abandoned by the Water Survey of Canada.

The following series of photographs of station 2 GC-9 were taken on June 30, 1969.

Station 2 GC-9 with the shelter and recorder removed.

Looking upstream from the end of the culvert. The pond is almost entirely hidden under the abundant vegetative growth.



Looking downstream through the culvert. The poorly-defined banks are covered with brush. With the flat control section, the brush could cause backwater during periods of intermediate to high flows.

Looking downstream from the station. The creek flows at the right, hidden by the bush. The flood-plain is very susceptible to surface flooding. From the precipitation records, a significant amount of rainfall had occurred during the two-week period prior to the photograph. The flat topography and poor drainage characteristics are evident throughout the channel portion of the downstream area of the basin.

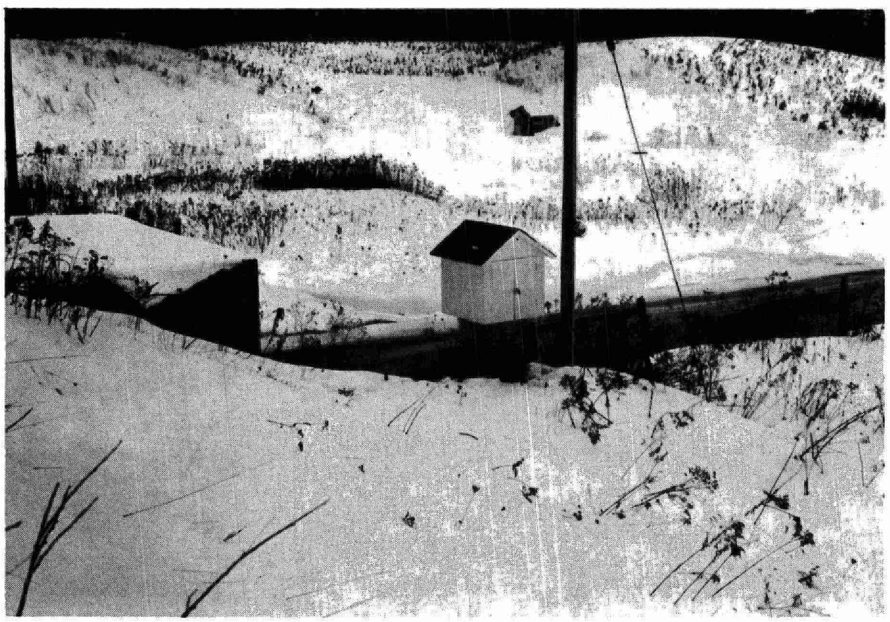
STATION 2 GC-21 (NR)*

Location: - lot 4, concession VIII, Township of Walsingham.
- presently downstream station for basin.

History: - October, 1966 - recording station installed by Water Survey of Canada, data rating: fair.

The daily discharges from September 1, 1966, to December 31, 1968, were plotted on graphs iv-vi for comparison to those from station 2 GC-9. The patterns of flow at the two stations show a definite correlation, as evident from the coinciding trends in fluctuations.

In early August, 1967, and late July, 1968, anomalies can be noticed in that flows at downstream station 2 GC-9 are recorded as being less than those at station 2 GC-21 further upstream. This can be explained by taking into account the heavy withdrawals of water from the creek between the two stations for irrigation purposes.



Station 2 GC-21 with gauge house and stillingwell.

* IHD designation natural control with automatic recording of water level.

STATION V-1 (NN)*

Location: - lot 4, concession XII, Township of North Walsingham.
- mid-basin station.

History: - August, 1965 - staff gauge installed by OWRC, River Basin Research Branch.
- 42 meter measurements and stage readings to date, rating curve is poor as control continues to erode, see Figure 2.
- discharge range recorded to date: 9.51 cfs - 51.68 cfs.

The 42 instantaneous discharges were plotted on graphs ii-v for comparison with the continuous hydrographs for stations 2 GC-9 and 2 GC-21. By joining the instantaneous measurements, a general pattern of streamflow is outlined which indicates an approximate, varying correlation between the discharges at station V-1 and those at station 2 GC-21.

As evident from the stage-discharge curve for the station, Figure 2, a periodic shifting of stage occurs, thereby increasing the difficulty of rating the station using only the existing staff gauge. The installation of an articifical control and stilling well was considered; however, due to the steep, sandy stream banks, sandy streambed and year-round relatively high flows (low stage, 10-20 cfs), construction of an automatic station would likely prove very difficult and therefore has not been attempted to date.

The change in streambed grade over the control creates high velocities and white-water turbulence. These points are visible in the photograph following.

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* IHD designation natural control with no continuous record of water level.

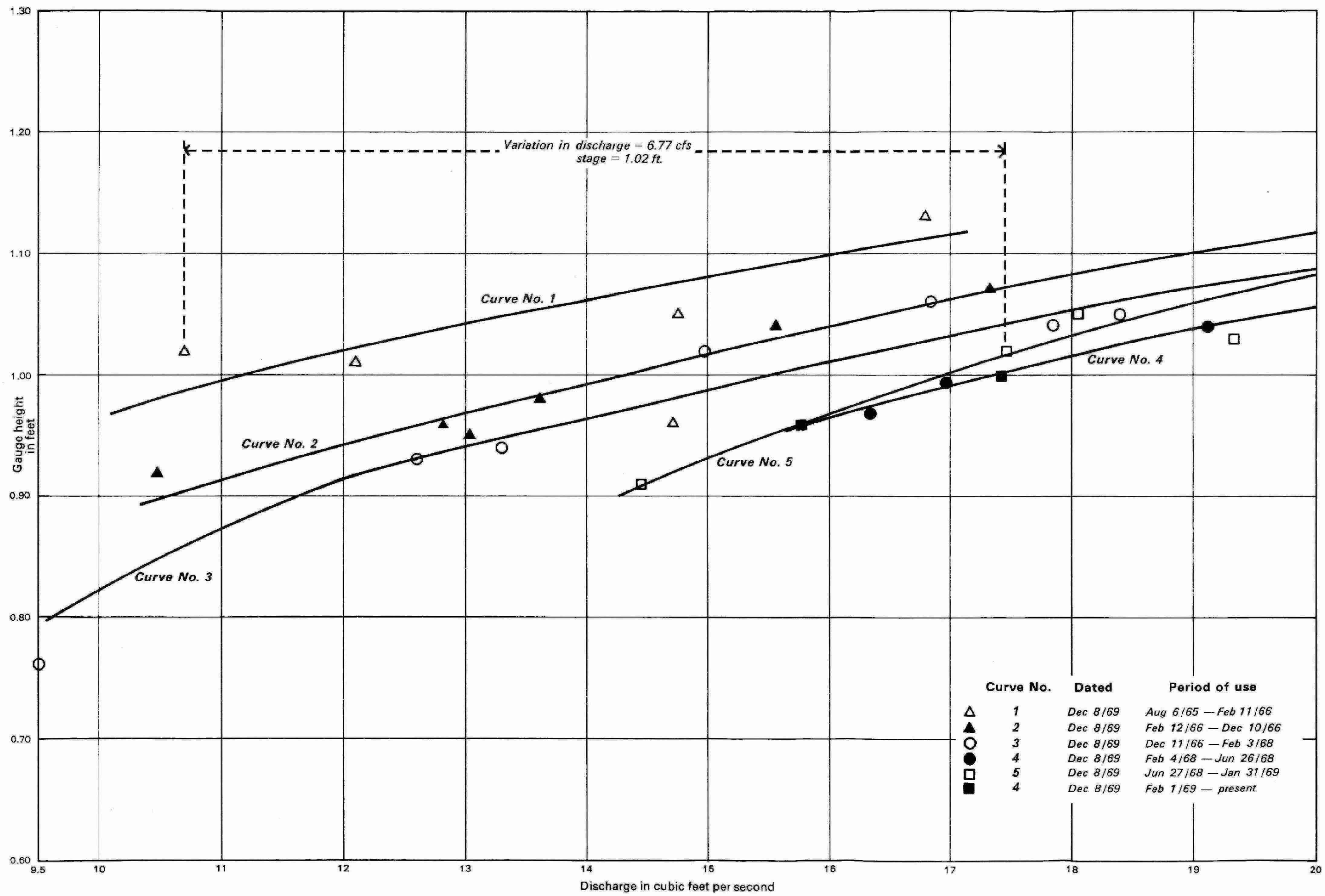


Figure 2. Low stage-discharge curves for station V-1, Venison Creek drainage basin.

Looking upstream over the control.
The staff gauge and pond appear in
the background.

In the second photograph, the changes in current pattern can be seen as the water flows over the crest of the control.

Looking downstream over the control
from the pond.

Both photographs were taken on June 30, 1969. The data recorded on that date are as follows:

Stage:	1.11 ft.
Discharge:	23.15 cfs
Average Velocity:	0.82 ft./sec.

STATION V-2 (NR)

Location:
- lot 13, concession III, Township of Middleton.
- headwater station.

History:
- August, 1965 - staff gauge installed by OWRC, River Basin Research Branch.
- April, 1968 - A-35 water-level recorder installed.

- 50 meter measurements and stage readings to date, rating curve is poor as control continues to shift, see Figure 3.

Monthly instantaneous discharges from August, 1965, to March, 1968, were plotted on graphs ii-v. The points were joined and a pattern very similar to that for station V-1 was found. From April, 1968, the mean daily gauge heights were compiled, where possible, from the water-level charts. A problem had developed with the proper functioning of the recorder and many reversals were missed, causing a periodic lack of data in the mean daily gauge height table, see Figure 4. To fill in these gaps by estimating discharges will likely be difficult, especially for the low-flow periods, because of the number of irrigation systems which operate between stations. The effect of withdrawals is clearly evident on Figure 5 which is a copy of a portion of the recorder chart for station V-2.

Considerable doubt exists as to the true meaning of the records collected. With the federal government's legislation in 1967, allowing expenses incurred by farmers for improving land drainage to be claimed as a direct capital expense for taxation purposes, tiling and ditching activities increased in the sub-basin above station V-2. The freshly-disturbed sand ditches were easily eroded and a considerable sediment load reached the stream. The pond at station V-2 silted in repeatedly and covered the intake. Monthly clearing was necessary; however, the sand did not plug the intake tightly. The fluctuations of the actual gauge height, as recorded, were probably dampened and the true position of upper and lower limits is not clearly evident on the chart.

Figure 6, which is a copy of a portion of the recorder chart for station V-2, can be used to illustrate the problem of determining true gauge heights for the station. After checking precipitation and temperature data, some of the increased streamflow, as shown on the chart for March 18, 19 and 20, is concluded to be the result of the precipitation and snowmelt. Note the stair step-like appearance of the record and the time at which the increases occur. Snowmelt due to rising

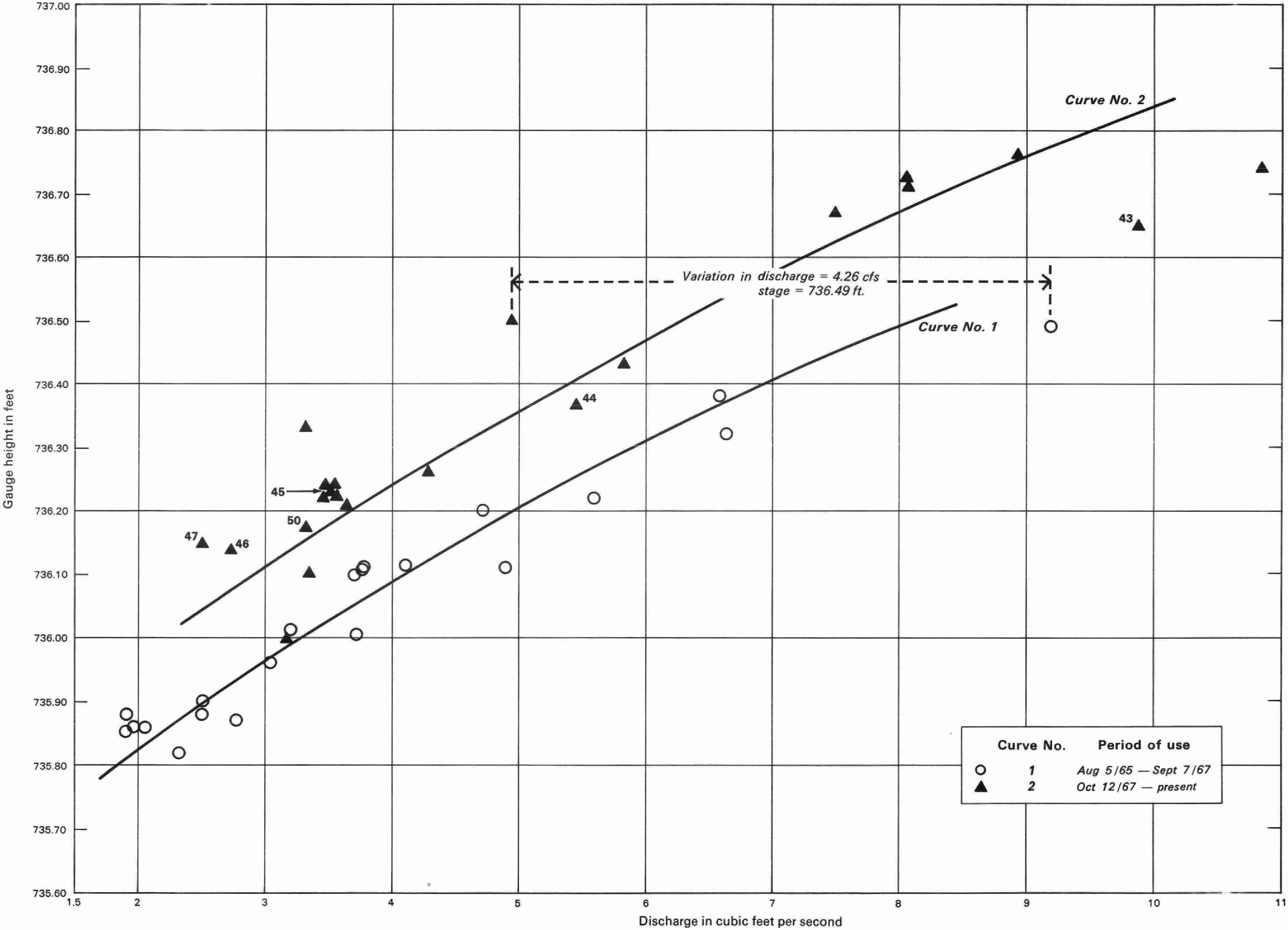


Figure 3. Low stage-discharge curves for station V-2, Venison Creek drainage basin.

Day	October	November	December	January	February	March	April	May	June	July	August	September	Day
1	736.19	736.34	736.87	736.56		736.39		736.53	736.51	736.35			1
2	736.18	736.33	736.87	736.55		736.38		736.50	736.69	736.35			2
3	736.25	736.32	736.81	736.51		736.39		736.47	736.79	736.34		736.13	3
4	736.25	736.31		736.46		736.39		736.47	736.65	736.35		736.12	4
5	736.24	736.30		736.43	736.93	736.36		736.42	736.54	736.47	736.24	736.13	5
6	736.23	736.30		736.41	736.81	736.35		736.39	736.59	736.44	736.23	736.12	6
7	736.25	736.31	736.69	736.35	736.73	736.35	736.91	736.38	736.62	736.38	736.23	736.13	7
8	736.25	736.34	736.61	736.37	736.68	736.33	736.75	736.53	736.53	736.35	736.23	736.13	8
9	736.23	736.33	736.52	736.41	736.65	736.32	736.66	736.62	736.51	736.33	736.15	736.13	9
10	736.23	736.33	736.45	736.35	736.61	736.31	736.88	736.77	736.54	736.32		736.12	10
11	736.23	736.36	736.40	736.36	736.59	736.33	736.70		736.50	736.32		736.12	11
12	736.22	736.34	736.40	736.36	736.57	736.33	736.57		736.48	736.32		736.24	12
13	736.21	736.33	736.54	736.35	736.54	736.32	736.51	736.68	736.46	736.32		736.20	13
14	736.21	736.31	736.59	736.35	736.50	736.31	736.48	736.60	736.45	736.31		736.18	14
15	736.20	736.35	736.47	736.34	736.47	736.30	736.46	736.51	736.48	736.30		736.17	15
16	736.19	736.80	736.40	736.33	736.46	736.30	736.73	736.46	736.53	736.30		736.16	16
17	736.18	736.70	736.36	736.35	736.43	736.30	736.66	736.43	736.43	736.30		736.20	17
18	736.19	736.88	736.33		736.41	736.33			736.40	736.31		736.19	18
19	736.32	736.78	736.32		736.40	736.36			736.39	736.34		736.18	19
20	736.40	736.61	736.33		736.39	736.40			736.38	736.34		736.17	20
21	736.33	736.55	736.31		736.39	736.55	736.31		736.37	736.32		736.16	21
22	736.29	736.64	736.32		736.42	736.51	736.47	736.93	736.34	736.30		736.16	22
23	736.29	736.66	736.90		736.44	736.48	736.21	736.96	736.36	736.24		736.15	23
24	736.29	736.61	736.51		736.44	736.52	736.20	736.72	736.45	736.21		736.18	24
25	736.29	736.60	736.39		736.44			736.64	736.42			736.17	25
26	736.28	736.56	736.38		736.43			736.58	736.37			736.16	26
27	736.28	736.57	736.37	736.80	736.41			736.53	736.34			736.15	27
28	736.30			736.68	736.41			736.51	736.53			736.15	28
29	736.45						736.66	736.49	736.43			736.14	29
30	736.41		736.80				736.59	736.46	736.37			736.14	30
31	736.36		736.71					736.42					31

For the period

Maximum instantaneous gauge height: 737.80 feet at 12:00 midnight on April 21, 1969.

Minimum instantaneous gauge height: 736.00 feet at 7:00 p.m. on July 25, 1969.

Figure 4. Daily gauge heights for station V-2, Venison Creek drainage basin, for year ending 30 September, 1969.

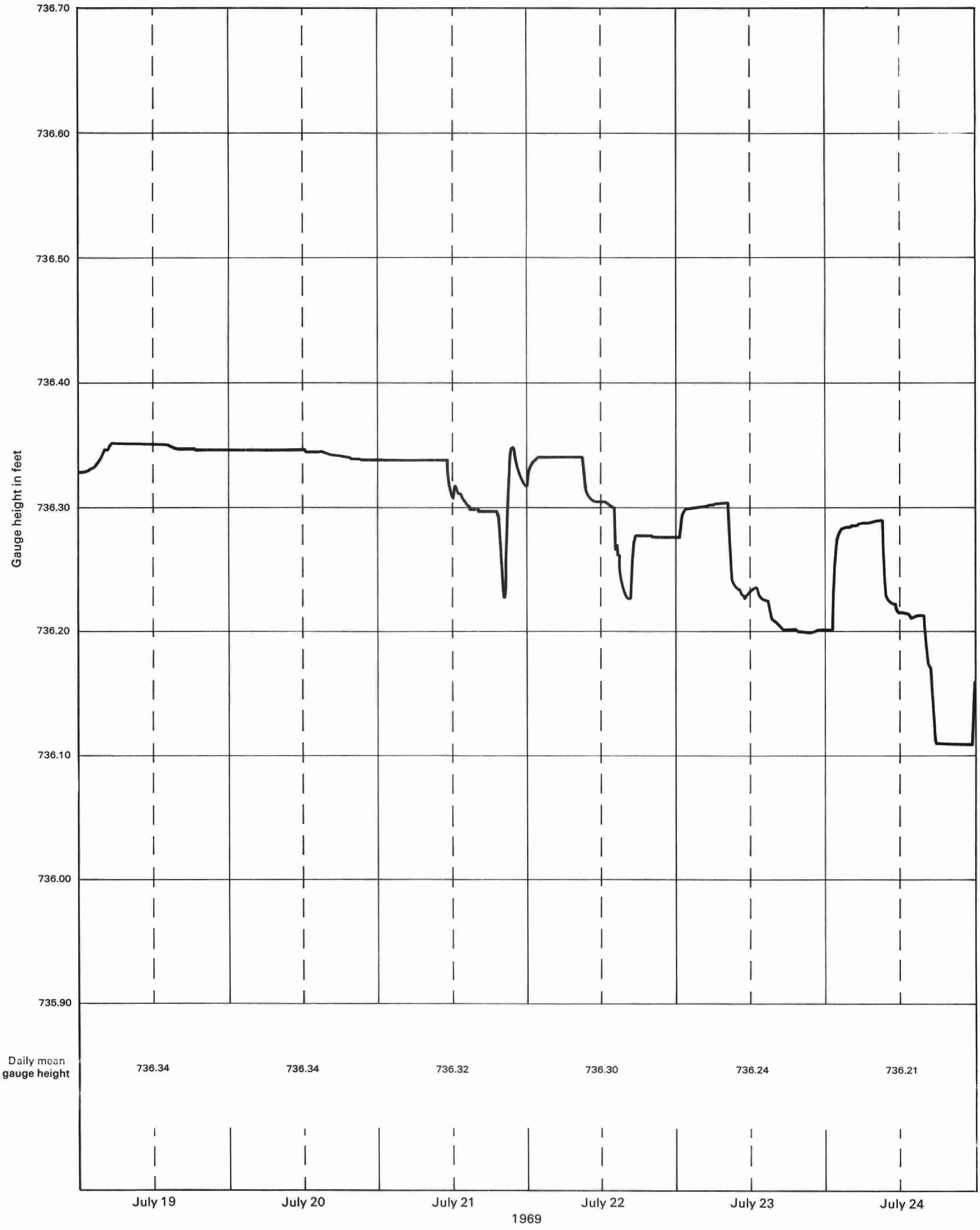


Figure 5. Stream water-level graph for station V-2, Venison Creek drainage basin, July 19-24, 1969.

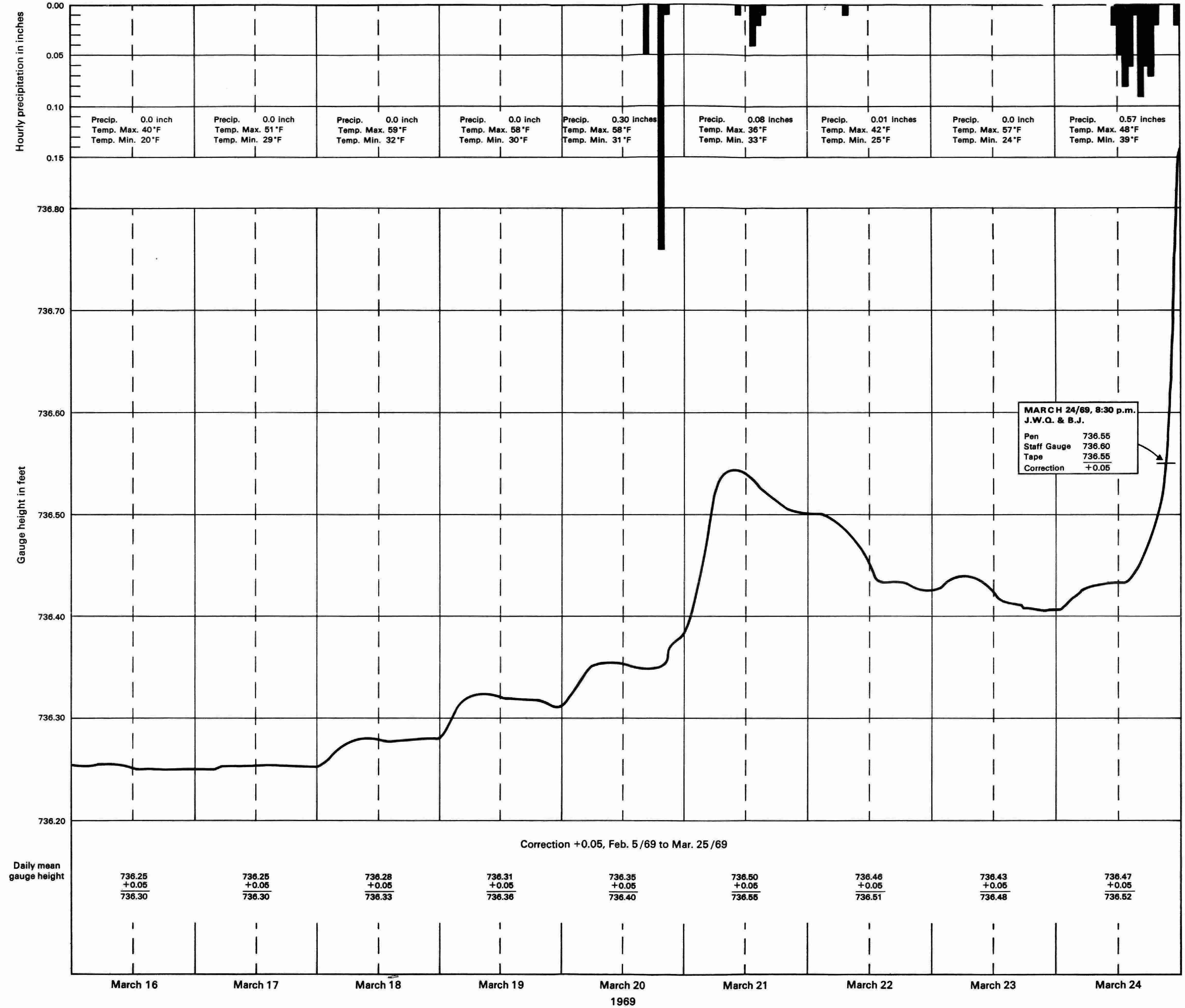


Figure 6. Stream water-level graph for station V-2, Venison Creek drainage basin, March 16-24, 1969.

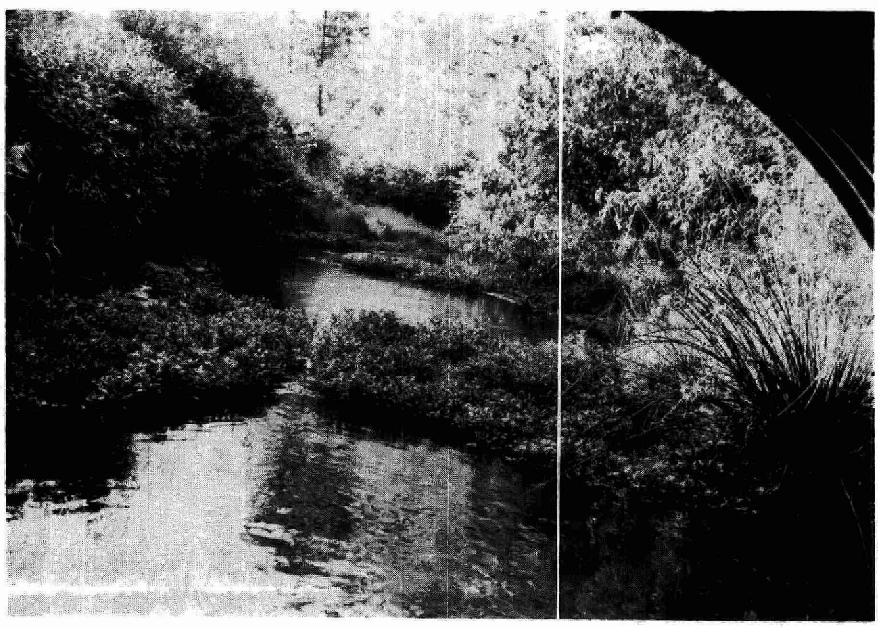
temperatures during the day is reflected in periodic rises in stage, beginning at midnight of the 18th, 19th and 20th. This phenomenon indicates an effective time lag of approximately 12 hours, assuming that the air temperatures causing melt become critical around noon of the preceding days. These findings are further supported by the fact that the rise in water level due to the high temperature on the 17th did not occur until after midnight. No rise is evident on the 17th itself because of the relatively low temperatures on the 16th which prevented any significant snowmelt.

Because of the dampening effect due to the silting of the intake, it is difficult to make an accurate correction to the gauge heights. A correction of +0.05 foot has to be applied over the period affected to allow for the difference in the staff gauge and stilling-well readings; however, it is difficult to know whether or not the error is a constant or actually has some accumulative effect on the record. In addition, the variation in stage due to the time lag mentioned above may also be contributing to an erroneous interpretation of true stage.

Daily discharges have not been tabulated as a stable station rating curve does not presently exist. Figure 3 suggests that several curves will likely result when the individual measurements are analysed and the applicable points grouped. The meter measurements appear to be continually plotting upward on the rating curve, which denotes a shift in the control.

A series of photographs were taken at different times during 1969 to help establish the cause of the problem. The initial assumption was that the metal culvert was acting as the control; however, from the photographs, it would appear that the weed-bed at the downstream end of the culvert is influential as a control. As the water surface is almost level in the pond area upstream of the weeds, the weed-bed appears to have a controlling effect on the stage-discharge relationship.

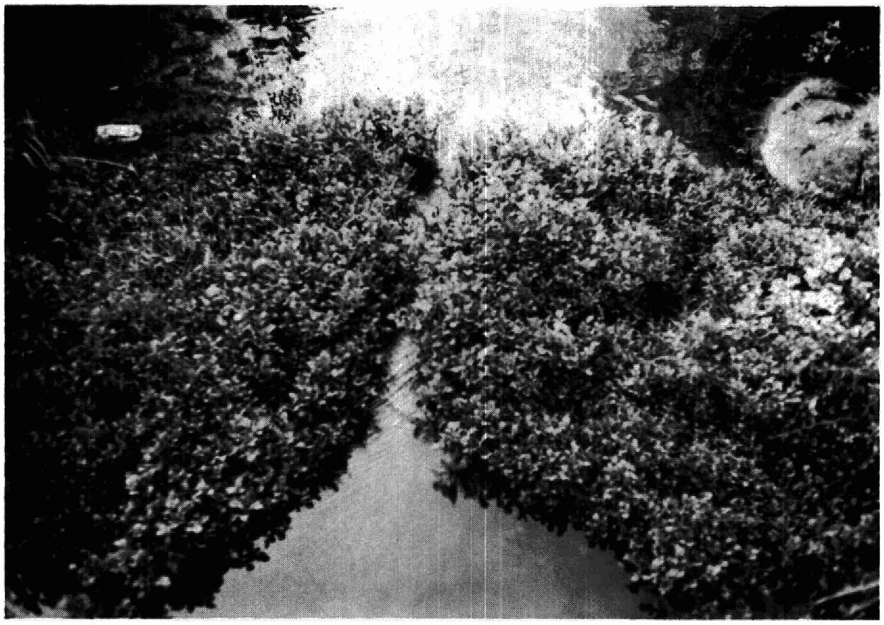
Looking downstream through the culvert.
Staff gauge is in pond in the foreground.
Note the weed-bed downstream of the culvert.



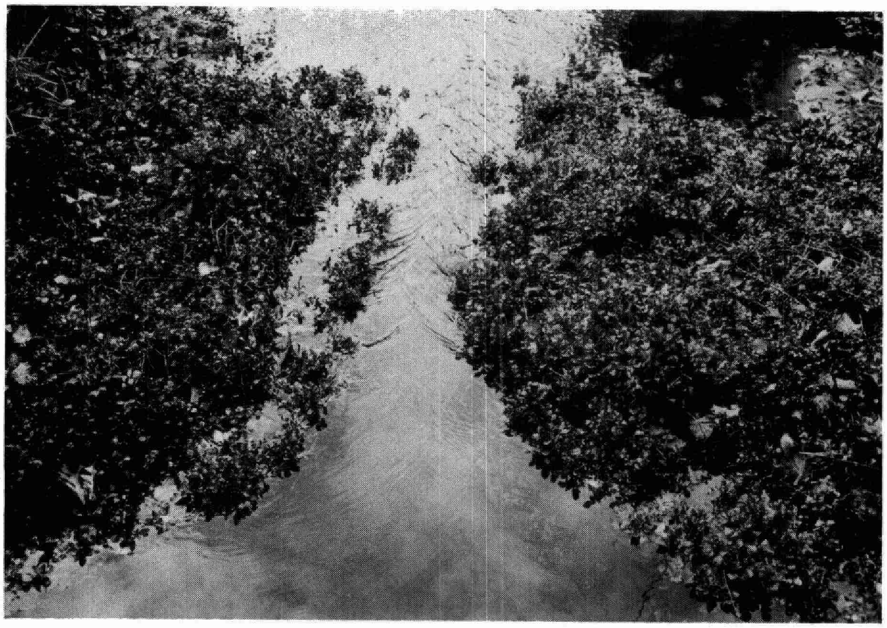
Looking downstream of the culvert at the weed-bed.

The effect of the weed-bed on the stage-discharge relationship can be verified by the following series of photographs taken at various times from June 30, 1969. The first was taken early in the growth period of the plant, the second and third at mid-season near full bloom, the fourth in the early fall, and the fifth in mid-January, 1970. The third photograph was taken from a different location to point out the massive and dense growth.

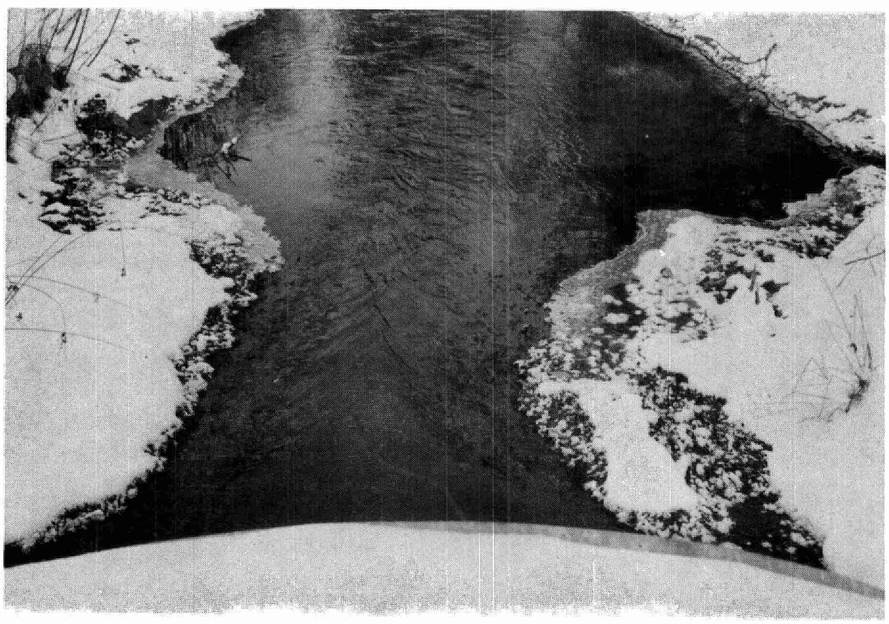
June 30, 1969.
Meter Point No. 44 on Figure 3.
Gauge Height = 736.37 ft.
Discharge = 5.44 cfs.



September 8, 1969.
Meter Point No. 46 on Figure 3.
Gauge Height = 736.14 ft.
Discharge = 2.72 cfs.



October 14, 1969.
Meter Point No. 47 on Figure 3.
Gauge Height = 736.15 ft.
Discharge = 2.50 cfs.



January 16, 1970.
Meter Point No. 50 on Figure 3.
Gauge Height = 736.17 ft.
Discharge = 3.33 cfs.

All measurements are shown plotted on Figure 3. Point No. 43, taken on June 2, 1969, plots lowest on the stage-discharge curve in relation to the other points. The plants at that time were in the initial stages of growth and the sand channel had been eroded to its lowest point by the high spring flows. A slight shift is evident with point No. 44. Points No. 45 through No. 47 show a considerable shift upward with the plant growth. Points No. 48 and No. 49 also plot high, as there were no high flows in November and early December to erode the sand bed and reduce the dense vegetative matter. The cold temperatures of late December and January destroyed the exposed plants, thereby diminishing the controlling effect of the weeds considerably. Point No. 50, taken on January 16, 1970, plots lower and more in line with Point No. 44.

As evident from the stage-discharge plots on Figure 3, the general trend over the four-year period of record has been toward an upward shift. The cause appears to be the plant growth in the stream channel. High flows and cold temperatures present only temporary set-backs for plant growth. Attempts at removing the weed-bed have proven to be only temporarily effective.

<u>STATION V-3</u> (NR)

Location:
- lot 14, concession III, Township of Middleton.
- headwater station.

History:
- August, 1965 - staff gauge installed by OWRC, River Basin Research Branch.
- April, 1968 - A-35 water-level recorder installed.
- 42 measurements and stage readings to date, rating curve is good. Curve has been developed for a range of stage from 740.42 feet to 741.00 feet covering the range of discharges from 0.66 to 8.15 cubic feet per second. This rated range of stage is no longer being metered. Low flow and high flow measurements are needed to complete the station rating.

The monthly instantaneous discharges for station V-3 from August, 1965, to April, 1968, were plotted on graphs ii-v. The points were joined and a general pattern very similar to those for the other stations developed. The mean daily gauge heights have been compiled and the corresponding discharges computed for the existing rating. These discharges have been plotted on graphs v-vii. The breaks which occur on the discharge hydrographs are for high or low flows outside of the range of rated flows. Once the rating curve is completed, these points can be plotted and the annual station summaries completed.

After analysing each instantaneous measurement, a large number of the points collected annually from September to April were found to plot above the existing rating curve. Unfortunately, from August, 1965, to August, 1968, backwater was not recognized as a problem at this station and consequently there are no records of conditions downstream of the control. It is assumed that, at least in part, herbaceous growth downstream of the control has caused a shift in stage readings during certain intervals. The greatest difference is three-hundredths of a foot; however, without stage corrections for the time of measurement, it is difficult to estimate the true correction to be applied to the plotted points to account for backwater and the annual periods of shift. As these high points were used in determining the rating curve, it may be drawn slightly higher than it would have been had the backwater been discovered earlier.

The plants growing in the stream are of the same type as those growing at station V-2. These have long runners originating from a main, massive root system which float parallel to the flow. Rapid and dense growth eliminates the possibility of keeping the channel clear for any considerable length of time. As the coldest water temperature recorded to date at station V-3 has been 36°F, the plants which are submerged in the water are protected from freezing and continue to live throughout the winter. Several hours were spent during December, 1969, removing most of the plants from the channel and a stage correction of 0.10 feet was noted. The degree of accuracy of this stage correction and also the accuracy involved in applying this correction to the immediate past data, (November, 1969 - December, 1969) reflect some doubt as to the absolute reliability of the records.

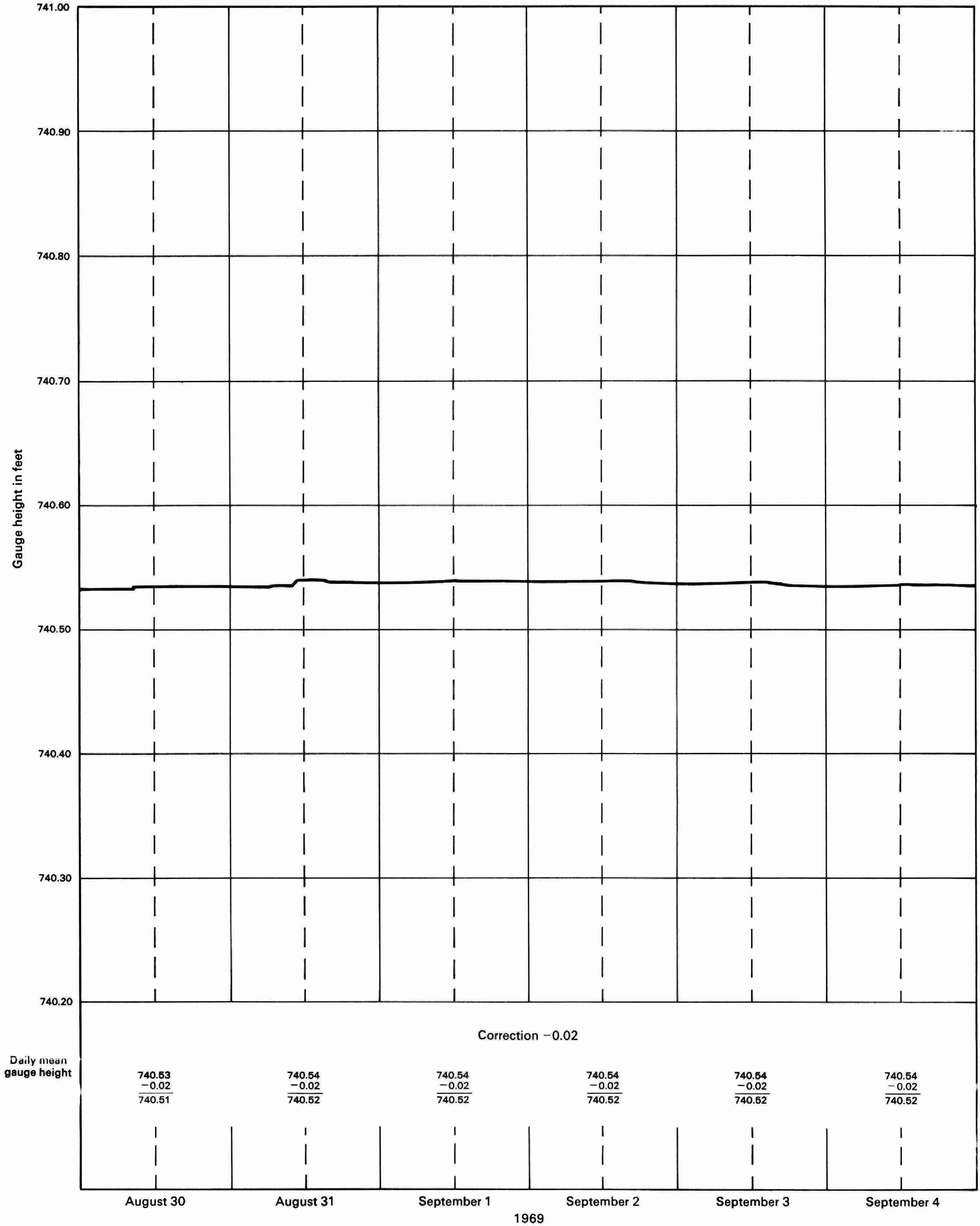


Figure 7. Stream water-level graph for station V-3, Venison Creek drainage basin, August 30-September 4, 1969.

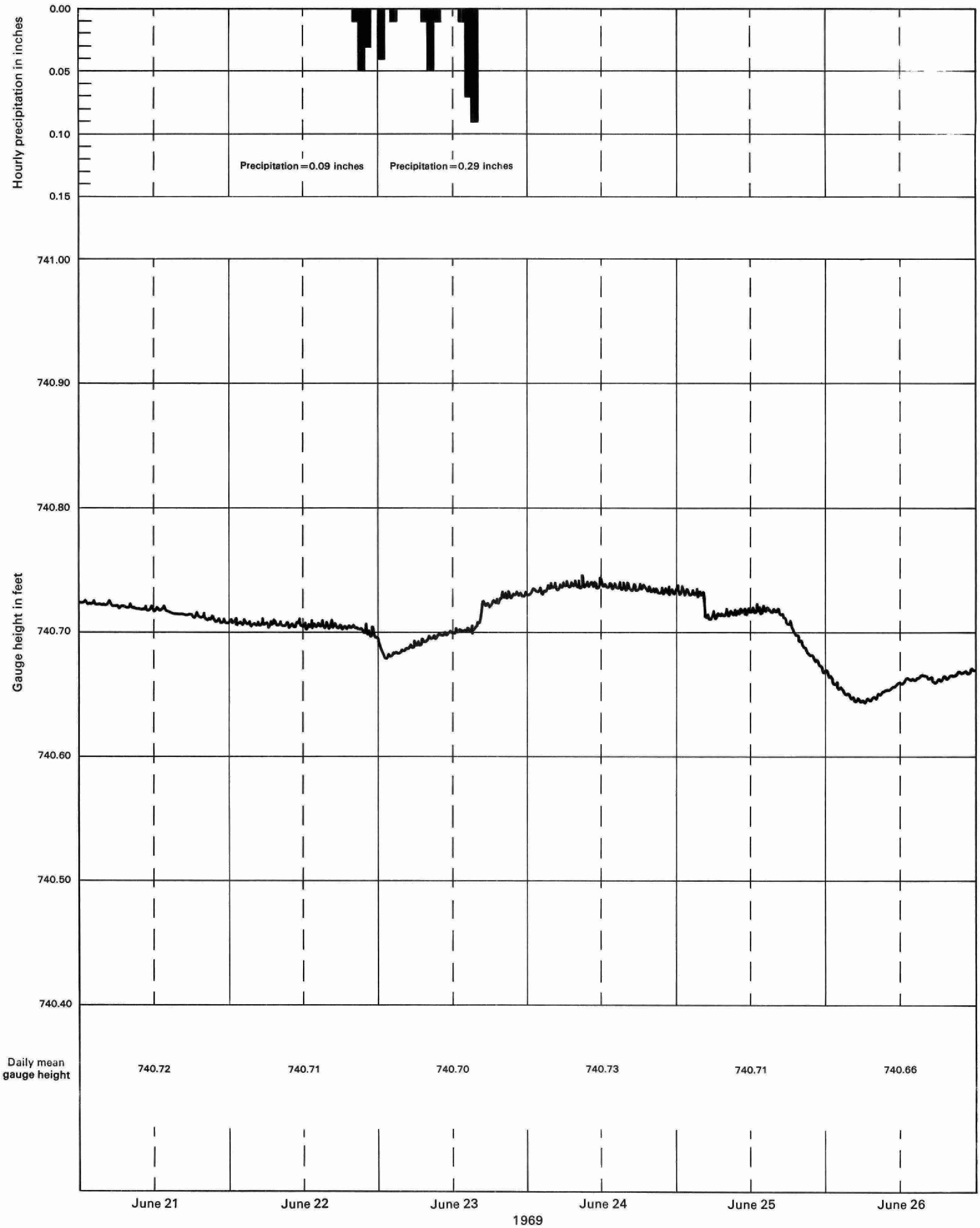


Figure 8. Stream water-level graph for station V-3, Venison Creek drainage basin, June 21-26, 1969.

Although station V-3 has provided the most consistent data of all the stations in the basin, abnormalities exist with the recording of stages above an elevation of 740.60 feet. Figure 7 is a copy of a portion of the recorder chart from station V-3 during the low flow period in 1969. This is considered to be a normal recording from an A-35 recorder. The recording shown on Figure 8, when the stage was above 740.60 feet, indicates a wave action. This wave action has appeared on the chart since the second day after the recorder's installation for the majority of stages above 740.60 feet. Close-by traffic vibration, if causing the wave action, should be effective at all stages, not only above a certain level. No explanation for the wave-like effect can presently be given.

In conjunction with the wave action, the stage is recorded with numerous stairstep fluctuations instead of the usual gradually ascending and descending curves. In order to analyse this step-like behaviour, the precipitation records for the period were added to Figure 8 and the irrigation permits for the onstream ponds, one being located approximately 200 feet upstream, were checked. Precipitation does not appear to have caused the step-like effect noted. As for possible irrigative withdrawals, the water-taking records submitted do not report any practice of irrigation until late in July, 1969. One other possible factor, the condition of the intake, can also be ruled out as a cause. The intake has never silted in at the station.

The stair-step changes in water level may be caused by floating logs and other debris temporarily clinging to the control or in the weed-beds and the fence downstream of the control. Such debris could cause a temporary shift in stage. The possibility exists that floating debris becomes significantly effective during high and intermediate flows. The control itself is formed by a flat-bottom corrugated metal culvert with the controlling section located about three-quarters of the way inside the culvert. Because of the location of the controlling section, it is very difficult to clearly study the control and note backwater or shifting and

to observe debris temporarily clinging to it.

The fence crossing the stream downstream of the control does provide support for debris that could collect and possibly affect the upstream rating. In fact, both debris on the control and on the fence have been noted causing effects at different times in the past; however, this has been observed only at low flow stages from August through November, when the stages were at 740.60 feet or lower, and the wave action and step-like appearance were not noted.

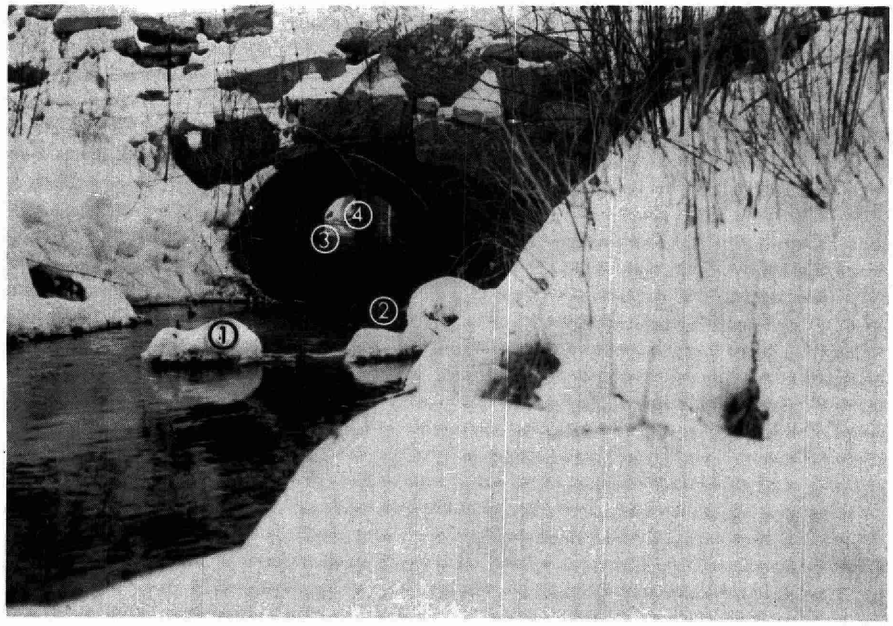
On January 16, 1970, the following two photographs were taken of the control at station V-3 and the area downstream. The stage on this day was below 740.60 feet. The following should be noted in the first photograph:

(1) the log in the foreground partway across the channel,

(2) the slight free-fall of the flow leaving the culvert,

(3) the controlling section mid-way in the culvert, and

(4) the smooth surface of the water in the pond.



Looking upstream towards the controlling section in the culvert. A portion of the staff gauge is visible in the background at the upstream end of the culvert.

The following should be noted in the second photograph:

(1) the darker areas in the water at points along the banks are plants (at this time of the year, the plants are at their lowest stage of growth),

(2) the constriction in the channel starting approximately 60 feet downstream from the culvert and continuing beyond the fence,

(3) the wire fence across the channel, and

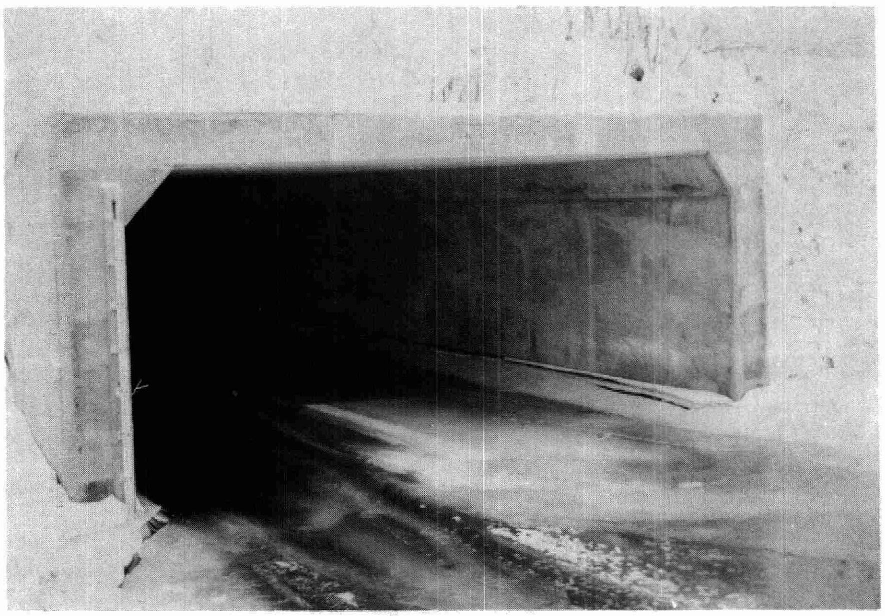
(4) the log caught to the right of the channel in the fence.

Looking downstream from the culvert.

GENERAL OBSERVATIONS

Ice Conditions

A few general comments can be made from past ice observations in the basin. Ice does not appear to be a problem in the upper-half of the basin. At station V-1, ice usually appears attached only along the bridge foundation throughout the controlling section. Downstream of the station, one to two inches of clear, hard sheet ice floating on the water surface is not uncommon. Sheet ice of this nature presents minor problems in measuring streamflow. The extent of the ice cover on the creek at station 2 GC-21 was photographed on January 16, 1970.



Looking downstream through the culvert invert.

Irrigation

The density of irrigation systems withdrawing water directly from Venison Creek are shown on Figure 9 which is a copy of a portion of the water-taking permit

map for the Venison Creek basin, as compiled in December, 1969, by the Water and Well Management Branch. Irrigation operations during July and August greatly increase the problems of streamflow data compilation, computation and correlation.

Data Correlation

The area of the Venison Creek basin and the areas of the sub-basins have been calculated and are summarized in the following table. Reference should be made to Figure 9 to review these areas.

Station	Drainage Area in sq. miles	Per Cent Area of Basin
2 GC-9	34.46	96.60
2 GC-21	29.18	81.79
V-1	17.76	49.77
V-2	6.22	17.44
V-3	3.76	10.53
Area below station 2 GC-9	1.22	3.40
Total area of basin	35.68	

Instantaneous discharges for stations 2 GC-9, V-1, V-2 and V-3 were examined in an attempt to derive simple correlations. The difference between each of the discharges were compiled and included on graphs ii-v. Attempts were made to correlate runoff to area of drainage in order to derive an approximate discharge per unit area.

Example:

Date: - March 1, 1967.

Conditions: - no irrigation, ground frozen, no precipitation, maximum daily temperature over previous seven days less than 32^{o}F.

Assumption: - baseflow conditions.

Streamflow (instantaneous): - V-2 = 3.72 cfs
- V-3 = 1.82 cfs
- V-1 = 16.85 cfs

Correlation $\frac{V\text{-}2}{V\text{-}3}$:

$$\frac{A_{V-2}}{A_{V-3}} = \frac{6.22}{3.76} = \frac{1.65}{1} \equiv \frac{2}{1} \qquad A = \text{Area (square miles)}$$

$$\frac{Q_{V-2}}{Q_{V-3}} = \frac{3.72}{1.82} = \frac{2.04}{1} \equiv \frac{2}{1} \qquad Q = \text{Discharge (cfs)}$$

Approximate discharge per square mile = 0.5 cfs for V-2 and V-3.

The above linear correlation appears to indicate that similar conditions of ground-water discharge per unit area exist for the drainage areas for stations V-2 and V-3. Upon examining the surficial geology of the sub-basins (see Figure 9), it is found that similar geologic conditions also exist.

Upon examining the unit-area discharge for the V-1 sub-basin (eliminating the effects of sub-basin V-2 and V-3) and comparing it to the unit-area discharge for V-2 and V-3, it would appear that the two sub-basins have different streamflow characteristics and cannot be correlated linearly on the basis of drainage area alone.

Correlation $\frac{V\text{-}1}{V\text{-}2 + V\text{-}3}$:

$$\frac{A_{V-1} - (A_{V-2} + A_{V-3})}{A_{V-2} + A_{V-3}} = \frac{17.76 - (6.22 + 3.76)}{6.22 + 3.76} = \frac{7.78}{9.98} = \frac{.78}{1} \equiv \frac{.8}{1}$$

$$\frac{Q_{V-1} - (Q_{V-2} + Q_{V-3})}{Q_{V-2} + Q_{V-3}} = \frac{16.85 - (3.72 + 1.82)}{3.72 + 1.82} = \frac{11.31}{5.54} = \frac{2.04}{1} \equiv \frac{2}{1}$$

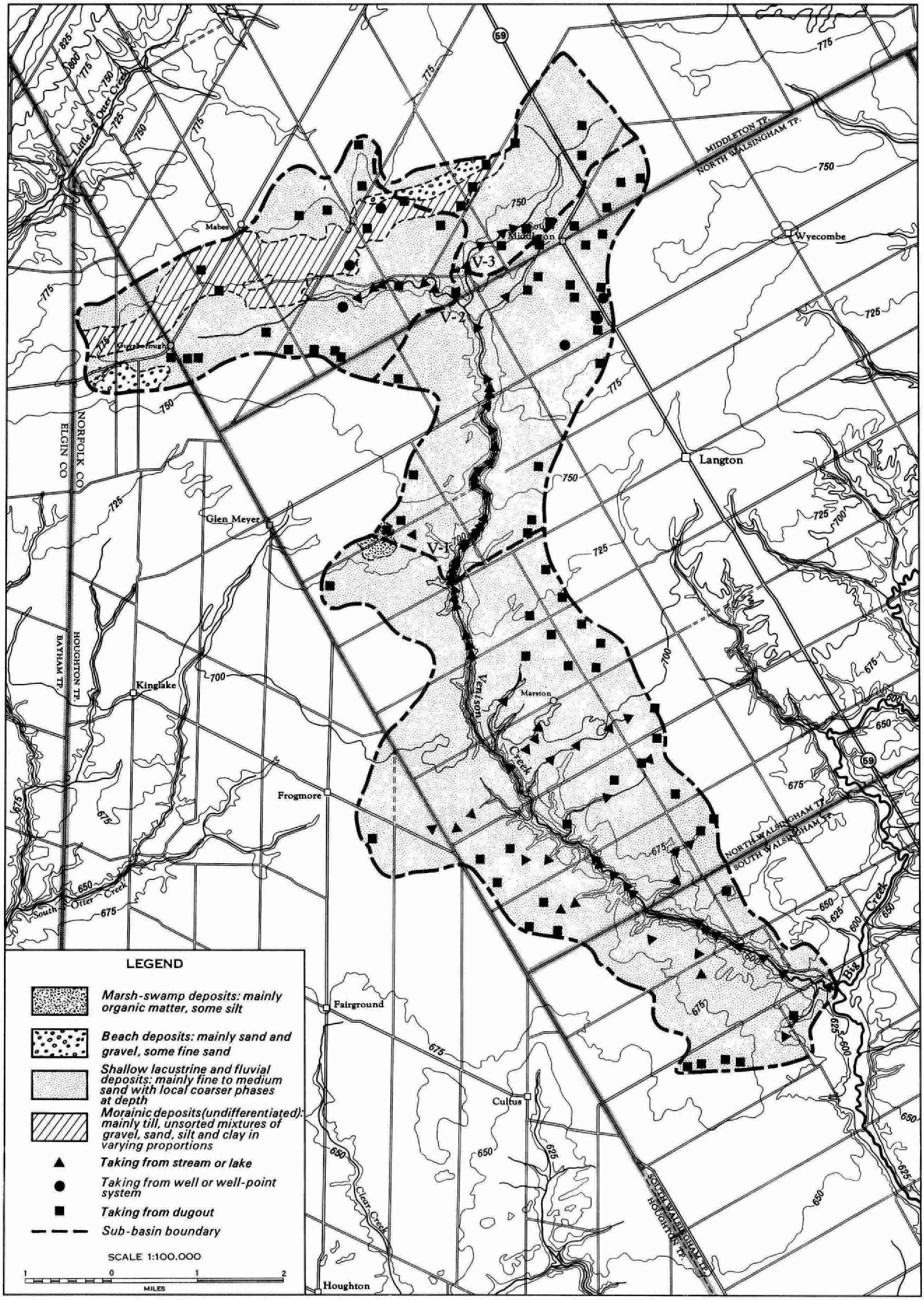


Figure 9. Surficial geology and location of water takings in the Venison Creek drainage basin.

Approximate discharge per sq. mile
for V-1 = 1.5 cfs

for V-2 and V-3 = 0.5 cfs

Examining the surficial geology of the drainage area for V-1 below and V-2 and V-3, see Figure 9, the reason for the variation in discharge per unit area becomes evident. It appears that the drainage area in question is composed entirely of sand deposits, whereas a till moraine exists in the drainage areas for V-2 and V-3, presumably causing changes in runoff characteristics.

In order to derive a correlation between stations 2 GC-21, V-2, V-3 and V-1 for purposes of simulation of continuous flows at station V-1 (presently a manual station), or at stations V-2 and V-3 (previously manual stations), it appears feasible to derive correlation coefficients using instantaneous discharge differences. This method, however, would not likely be applicable during the irrigation periods when water takings are extensive.

CONCLUSIONS AND RECOMMENDATIONS

1. The reliability of the discharge records for the original federal station 2 GC-9, having been affected by backwater, is unknown and therefore the data should be used with caution.

2. For the periods of simultaneous operation of stations 2 GC-9 and 2 GC-21, a correlation is visually evident from the hydrographs. If an actual correlation is derived, peak flows at station 2 GC-9 could possibly be interpreted using the data from station 2 GC-21; however, low flows during irrigation seasons would be difficult to simulate without more detailed water-taking records.

3. Station V-1 presently has a poor rating curve because of streambed changes. Simulation of daily mean flows may be possible by correlation with station 2 GC-21. The site of station V-1 should be further investigated to evaluate the feasibility of constructing a suitable artificial control.

4. At station V-2, silting and plant growth in the stream channel have prevented the establishment of a stable rating curve for the station. It is difficult to accurately assess the effects of plants in attempting to adjust past data; therefore, the data have to be accepted as calculated, but used with caution, knowing that the figures may show higher than actual values.

5. A thorough attempt should be made to eliminate the plant growth at station V-2, so that a more reliable rating curve can be established and to determine whether or not the metal culvert can in itself act as a stable control.

6. Station V-3 has developed a stable rating for the low to intermediate range of discharge. No problems are anticipated in developing the curve for the full range of flows.

7. Conditions of station V-3 should be observed carefully when the stage rises above 740.60 feet to determine the actual cause of the peculiar, repetitive,

short-duration wave action effect that appears on the hydrograph so that steps can be taken to remove the cause of this effect.

8. The plant growth in the streambed at station V-3 should be observed for its backwater effect, especially during intermediate and high flows from September to April.

9. If the plant growths in the streambeds at stations V-2 or V-3 become critical, an attempt should be made to remove the root systems or otherwise destroy the plants.

10. An attempt should be made to obtain as accurate and detailed information as possible on stream withdrawals in the basin, especially in that portion downstream of stations V-2 and V-3. Data on exact times of taking and the rates of withdrawal are essential for interpreting the streamflow for correlation studies.

11. Ground-water discharge to the stream appears to be of similar magnitude for the drainage areas above stations V-2 and V-3. The area between these two stations and station V-1, appears to have approximately three times the ground-water contribution compared to the areas above stations V-2 and V-3.

12. Correlation studies between stations 2 GC-21, V-3, V-2, and V-1 appear feasible for simulation of continuous flow records provided that corrections can be determined for water withdrawn in the basin for irrigation.

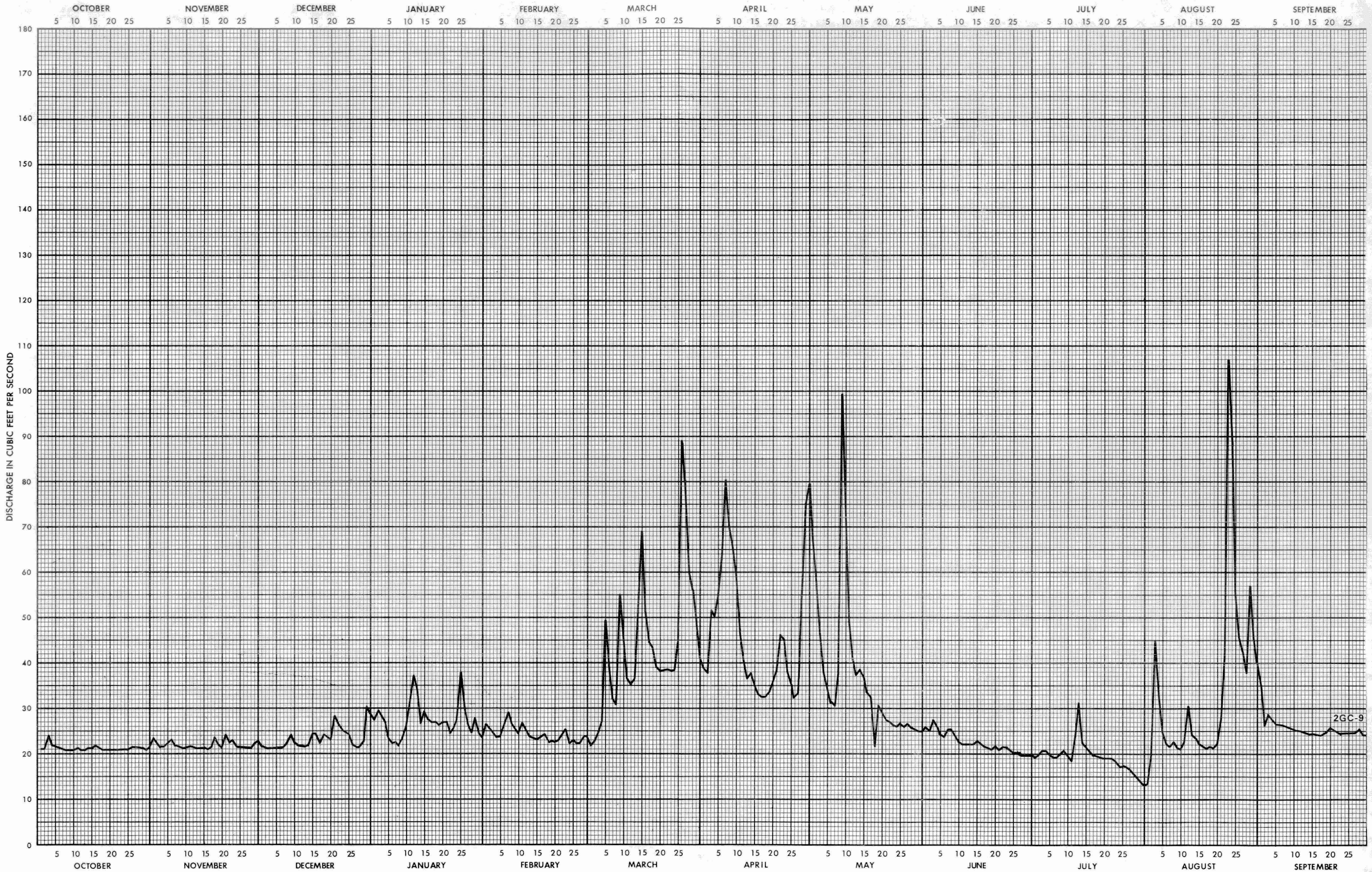
BIBLIOGRAPHY

United States Geological Survey Water Supply Paper No. 1898A

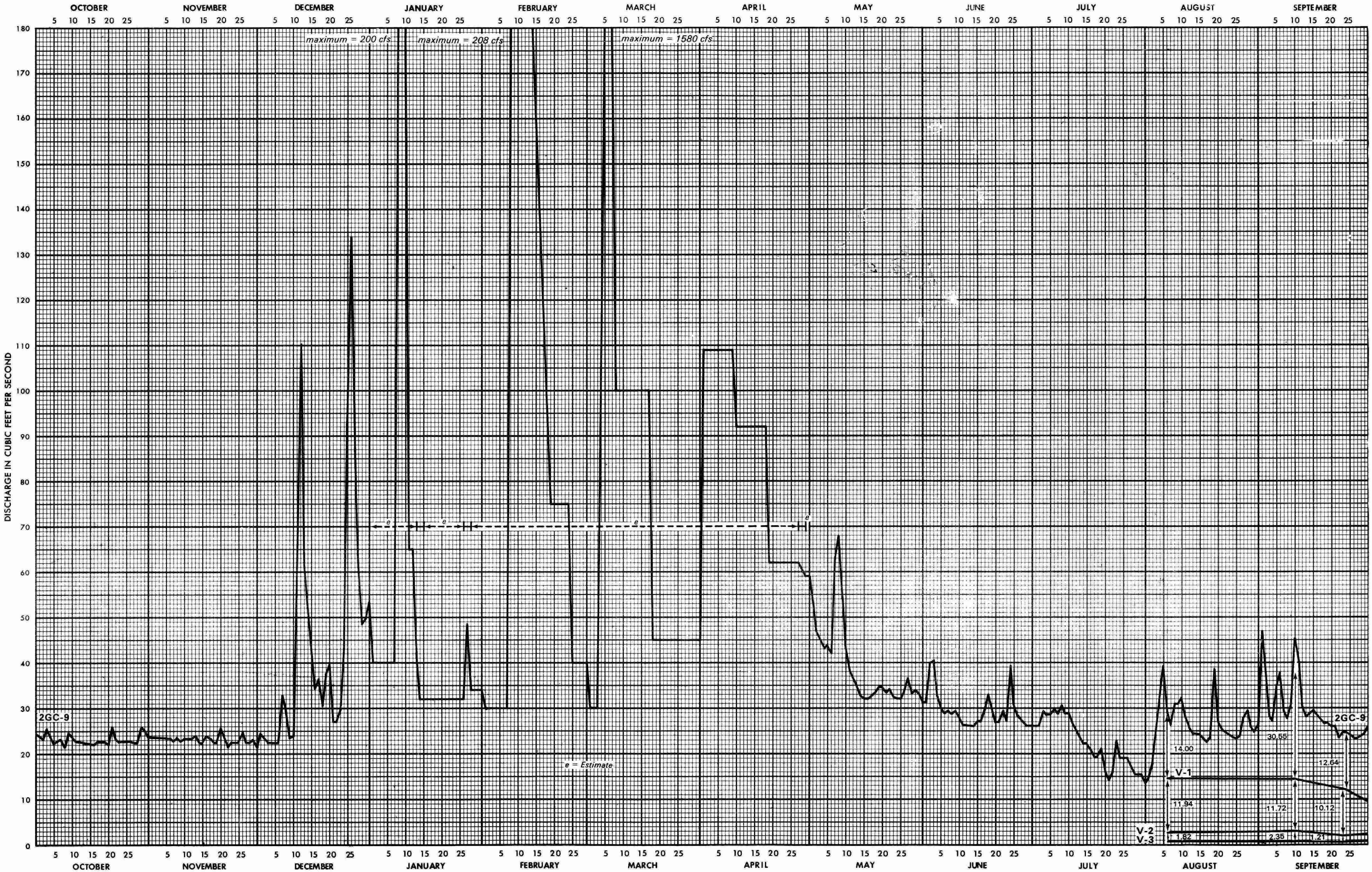
"Stage-Discharge Characteristics of a Weir in a Sand-Channel Stream"

APPENDIX

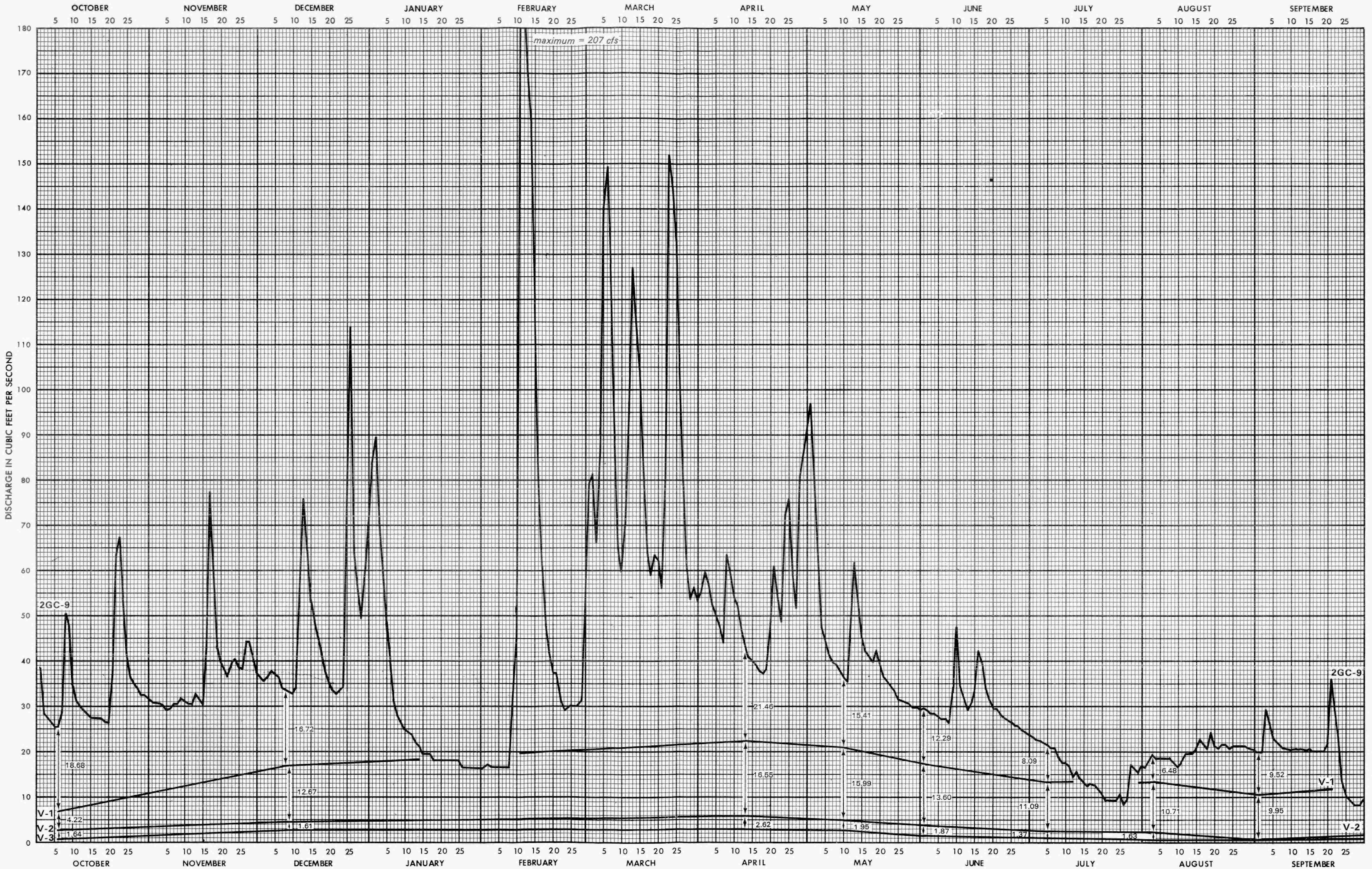
Graphs i-vii showing discharges at stations 2 GC-9, 2 GC-21, V-1, V-2, V-3 where available, for the years 1964 to 1970.



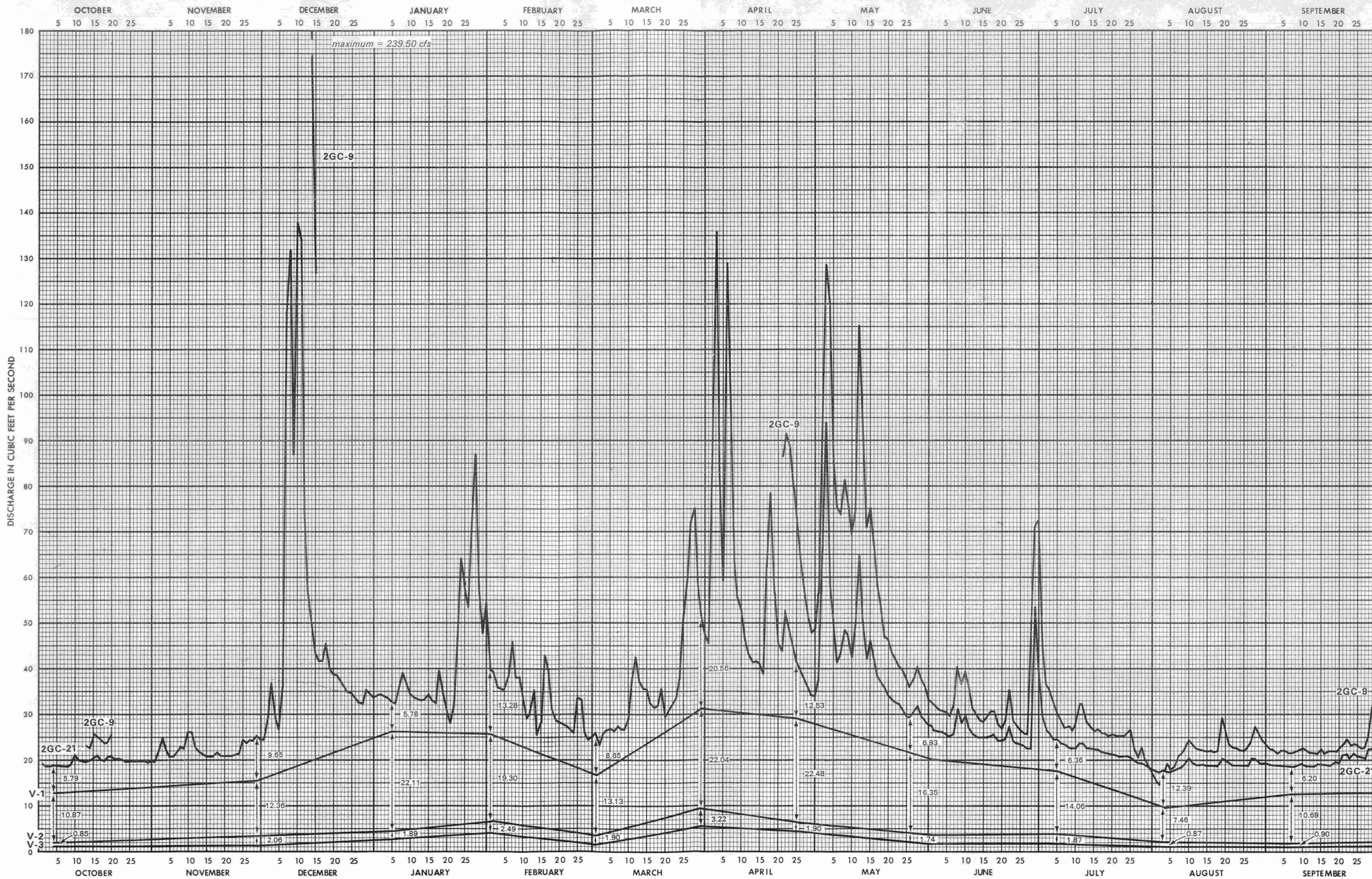
Discharge hydrograph for station 2GC-9, Venison Creek drainage basin, for year ending 30 September, 1964.



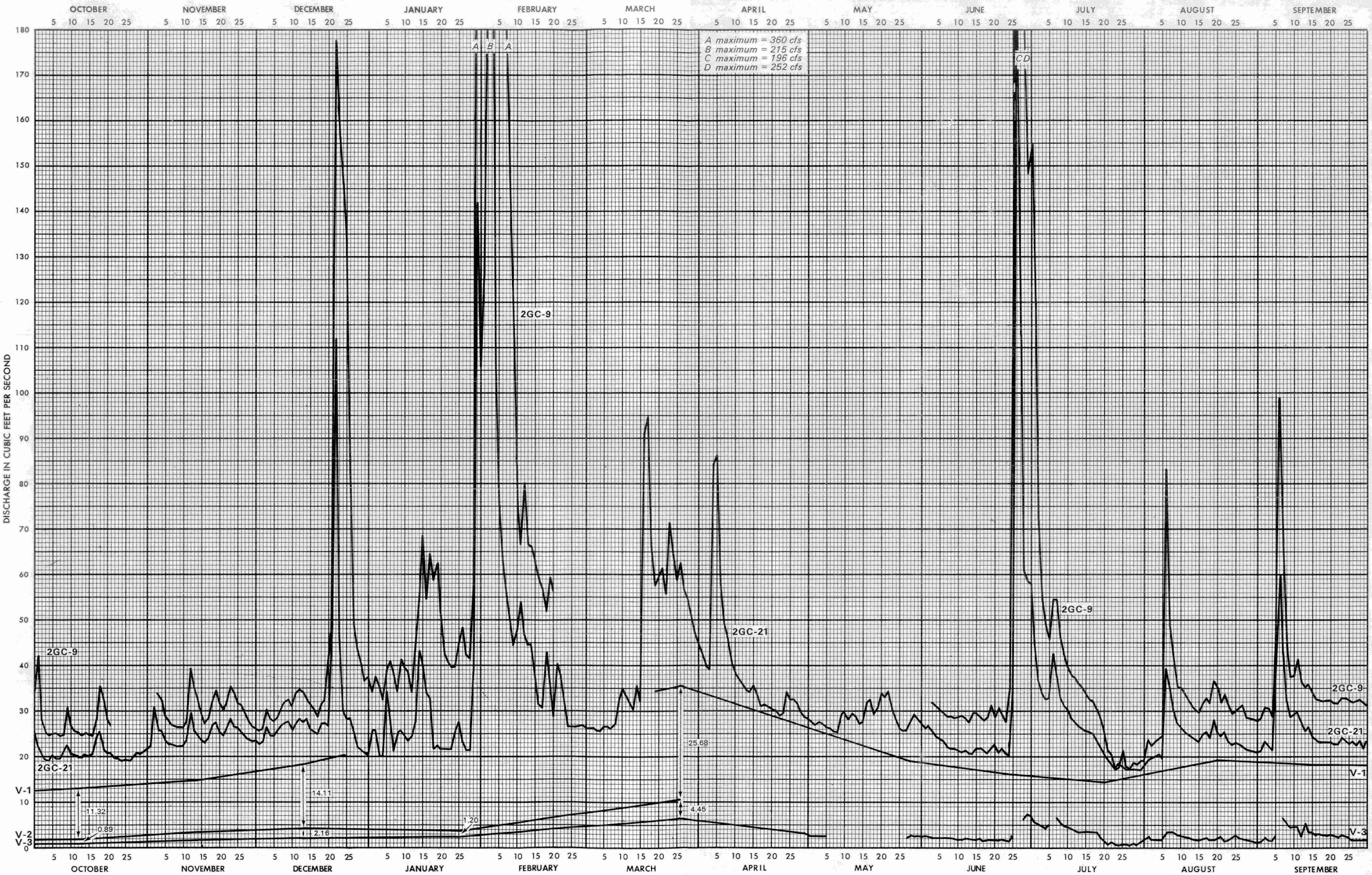
Discharge hydrographs for stations V-1, V-2, V-3 and 2GC-9, Venison Creek drainage basin, for year ending 30 September, 1965.



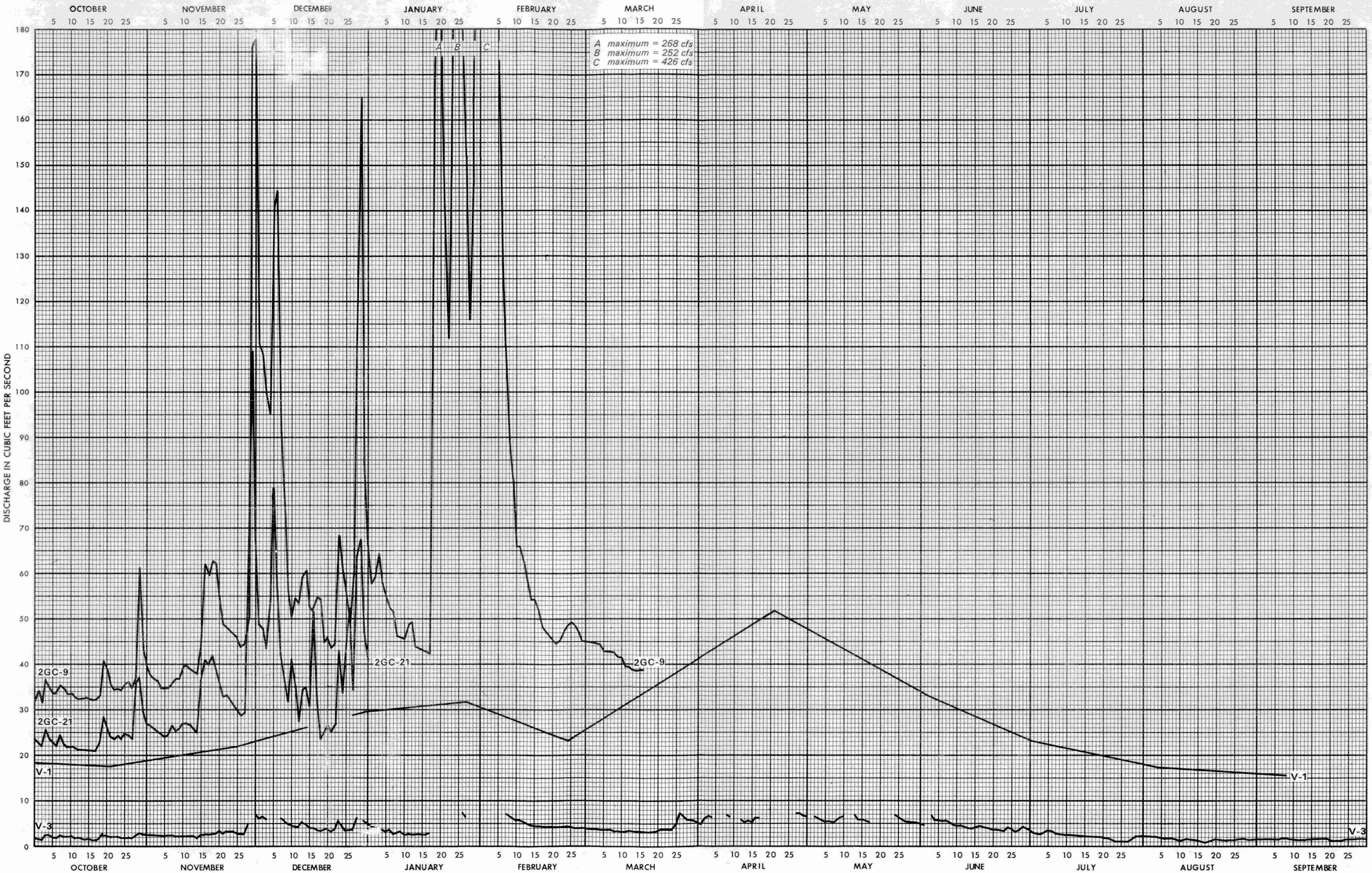
Discharge hydrographs for stations V-1, V-2, V-3 and 2GC-9, Venison Creek drainage basin, for year ending 30 September, 1966.



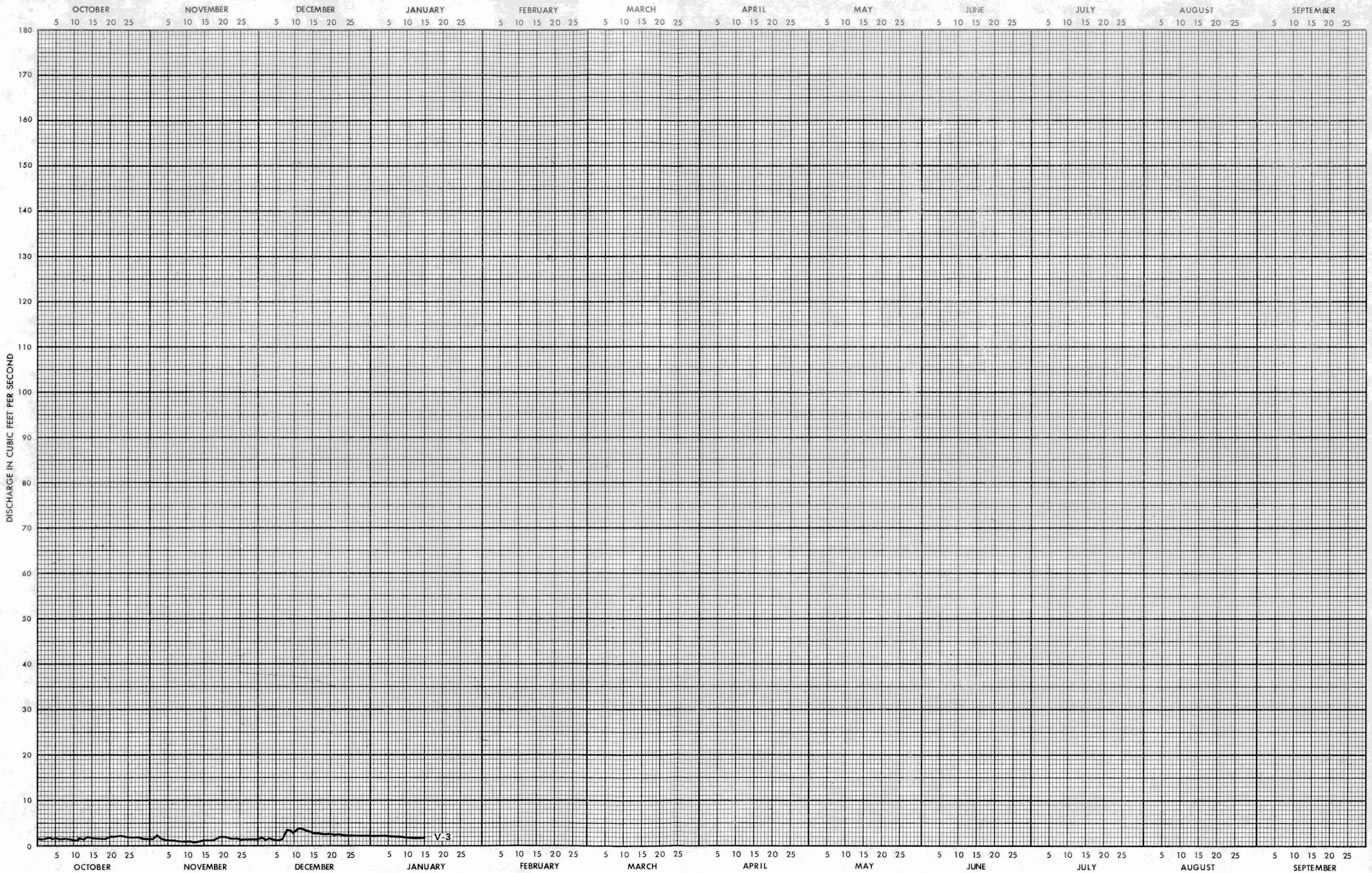
Discharge hydrographs for stations V-1, V-2, V-3, 2GC-9 and 2GC-21, Venison Creek drainage basin, for year ending 30 September, 1967.



Discharge hydrographs for stations V-1, V-2, V-3, 2GC-9 and 2GC-21, Venison Creek drainage basin, for year ending 30 September, 1968.



Discharge hydrographs for stations V-1, V-3, 2GC-9 and 2GC-21, Venison Creek drainage basin, for year ending 30 September, 1969.



Discharge hydrograph for station, V-3, Venison Creek drainage basin, for year ending 30 September, 1970.